Time Reversal Invariance Violation in Polarized Neutron Beta Decay

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Evidence for CP violation and it's implied consequence: T violation has been established in the neutral kaon system. Although there have been many searches for T violation in other systems, it has yet to be observed. The goal of the emiT experiment is to search for possible T violation in the beta decay of free polarized neutrons. This experiment is designed to detect a correlation of the form,

$$D\hat{\sigma}_n \cdot (\vec{p}_e \times \vec{p}_\nu)$$

which is odd under time reversal. A non-zero* triple correlation coefficient, D, would imply T violation. Several measurements of the D-coefficient were made and the current world average is $D=-(0.5\pm1.5)\times10^{-3}$ consistent with zero. The first run of the emiT experiment was conducted at the National Institute of Standards and Technology (NIST) Cold Neutron Research Facility (CNRF). The experimental apparatus, shown in Fig. 1, utilizes an octagonal array of detectors to observe, in coincidence, electrons and recoil protons from neutron beta decay. The neutrons in the cold (T=40 Kelvin) beam are polarized to more than 93% with a supermirror polarizer. Electrons are detected with four 50-cm long plastic scintillators. The recoil protons, whose maximum energy is less than 750 eV, are accelerated by a 36 kV potential onto thin window PIN diodes. The characteristic delay time between the decay proton and electron is used to distinguish signal from background. The proton drift time is greater than 0.5 μs and most backgrounds are prompt. Anticipated sources of systematic uncertainty were reduced in the detector design and measurements were made to assess the effect of certain crucial factors. The high neutron polarization and the high acceptance of the detector give this experiment a significant improvement in sensitivity over previous experiments. The analyses of the data taken from the first emiT run have been completed [1,2] and published in Phys. Rev. C [3]. The result, $D=-(0.6\pm1.2_{stat}\pm0.5_{syst})\times10^{-3}$ is consistent with zero. This value represents a small improvement over the current world average. The emiT collaboration is currently upgrading the detector for a second run at the NIST CNRF which is expected to take place in the fall of 2001. With this upgraded detector, we expect to overcome limitations experienced in the first and to improve the sensitivity to D to the 3×10^{-4} or less.

Footnotes and References

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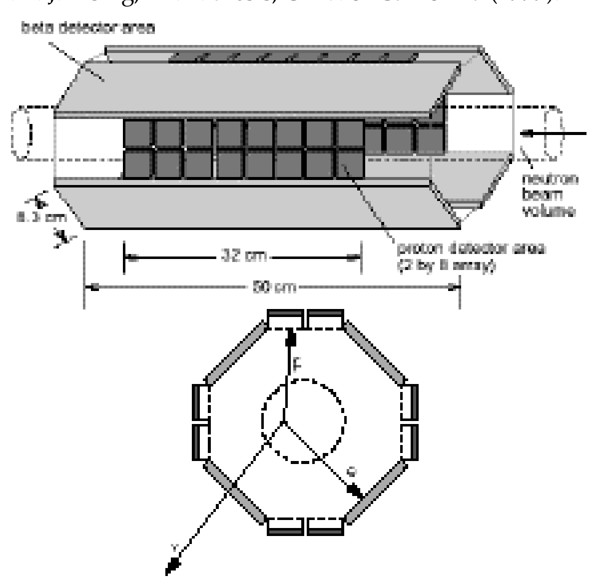
*Above final state interactions (FSI): $D_{FSI}=-5.7\times10^{-5}$.

1. S.-R. Hwang, Ph.D. thesis, Univ. of Michigan, (1998).
2. L. J. Lising, Ph.D. thesis, Univ. of California (1999).



3. L. J. Lising, *et al.*, Phys. Rev. **C 60**, (2000), 055501.

Fig. 1. Artist's conception of the basic detector geometry: an octagonal array of four each proton and electron detectors.